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Workflow for Publishing Forestry LCI Data through the LCA Commons

A Case Study

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Abstract

The USDA National Agricultural Library (NAL) maintains the Life Cycle Assessment (LCA) Commons, an open-access data repository. The LCA Commons supports the Federal LCA research community to advance LCA research through collaboration on matters of data transfer and access. NAL and USDA Forest Service (USFS) are collaborating to develop a consistent and repeatable workflow to systematically provide public access to life-cycle inventory (LCI) data for forestry and forest-based products. The workflow, which includes modeling, format conversion, and publication through the LCA Commons, must be demonstrated and documented so that researchers supporting the USFS LCA mission can publish data sets through the LCA Commons. NAL and USFS have collaborated to publish two unit processes for a distributed renewable energy production system, which NAL compiled into a product system model and published as a proof of concept for publishing a forestry data set. This proof of concept illustrates the scope of work required to efficiently publish data sets and assuring good data fidelity, and the functionality required of a full development-to-publication workflow. The proposed workflow document will become a standard reference for forestry LCI data submissions for the Forest Products Laboratory (FPL) in the future.

Keywords: life cycle inventory, LCI, database, LCA Commons

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Workflow for Publishing Forestry LCI Data through the LCA Commons

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Introduction

The Life Cycle Assessment (LCA) Commons (<https://www.lcacommons.gov/>) is an open, digital data repository hosted by the USDA National Agricultural Library (NAL). NAL is partnering with several federal agencies that maintain LCA programs, including the USDA Forest Service (USFS) Forest Products Laboratory (FPL), to provide public access to Federal LCA research data sets. This “Federal LCA Commons” team is committed to building capacity for life-cycle thinking nationally and globally and is dedicated to providing open access to U.S. government data sets and products through the LCA Commons. The Federal LCA Commons is a collaborative initiative among subject-matter experts from several U.S. government departments and agencies, including the U.S. Environmental Protection Agency; U.S. Department of Agriculture’s National Agricultural Library and U.S. Forest Service; the Department of Energy supported by the National Energy Technology Laboratory, the National Renewable Energy Laboratory, and Argonne National Laboratory; the Office of the Secretary of Defense; the Federal Highway Administration; and the National Institute of Standards and Technology. The Federal LCA Commons mission is to (1) advance LCA data, research, and information systems; (2) enhance modeling methods consistency; and (3) increase public access to life-cycle inventory (LCI) data. As for the FPL, we aim to build an internal standard workflow to illustrate how to submit forestry LCI data into the LCA Commons.

The objective of the LCA Commons program is to publish data sets suitable for reuse as secondary data. Data sets provided to the LCA Commons must be sufficiently documented to communicate the originally intended goal and scope to a secondary user (Arbuckle and others 2017). The ability to determine fitness-for-purpose of a data set related to a new research question is vital to ensure reliable results and analysis of an LCA. Thus, the data provider is responsible for fully documenting all models and data sets to be published in the LCA Commons, as well as verifying openLCA is calculating emissions and impacts as expected.

The LCA Commons platform is structured upon the openLCA data model. Data providers are required to prepare data sets in openLCA prior to submission. openLCA is an open source LCA software developed by GreenDelta (Berlin, Germany) (<http://www.openlca.org/>). Data sets can be transferred to NAL directly from the openLCA user interface. Modelers working in SimaPro (PRé Sustainability, Amersfoort, The Netherlands), GaBi (thinkstep Global, Leinfelden-Echterdingen, Germany), and other commercial software must restructure, document, and verify models in openLCA before transferring data sets to NAL.

Using a FPL distributed renewable syngas LCA product system as a case study, we describe the steps necessary to publish LCA data sets produced in SimaPro software to the LCA Commons (Anderson and others 2016). The FPL distributed syngas model is a simple representation of standard LCA datasets and is useful for illustrating the steps necessary to publish through the LCA Commons (Fig. 1). Additionally, a comprehensive step-by-step workflow for full LCA data sets with complete environmental inventory information that integrates seamlessly with other data sets submissions is currently a work in progress within the Federal LCA Commons.

Method

There are four major steps necessary to take this example data set from Simapro to publication: (1) SimaPro export, (2) model documentation and verification, (3) integration into openLCA, and (4) committing to NAL LCA Collaboration Server.

Export LCI Data Set from SimaPro

In this case study, the “wood chip pyrolysis; Tucker Renewable Natural Gas (RNG) thermochemical conversion process; at plant” and “whole tree chips, softwood, green, at sawmill, INW” have been modeled in SimaPro software v8.4 using USLCI database for upstream processes by FPL (Gu and Bergman 2016). Data sets are transferred between SimaPro and openLCA using a manual file exchange. The



Figure 1. Forestry LCI data modeling and converting into LCA Commons: (a) wood chips production facility; (b) process modeling diagram; (c) openLCA framework; (d) LCA Commons website.

pre-modeled LCI process data are exported and saved as EcoSpold v1 file selection in SimaPro (Goedkoop and others 2016). EcoSpold v1 is a data exchange format based on XML (Extensible Markup Language) used for LCI data and life-cycle impact assessment methods (Ecoinvent 2018).

Model Documentation and Verification in openLCA

Once the provider downloads the openLCA software, a new database may be created with complete reference data. Once the new database is created, the data sets, which now exists in EcoSpold v1, can be imported into the new database. Similarly, any impact methods used in the original analysis should be imported into the same database (Noi and others 2017). The provider can now document the data set in the metadata fields provided by openLCA and verify that it is functioning properly in openLCA.

Model metadata such as process, flow, actor, source, and parameter should be filled using recommendations in the LCA Commons Submission Guidelines (NAL 2017). The LCA Commons Guidelines synthesize elements and definitions from ISO 14048 (ISO 2002) and the International Reference Life Cycle Data System (ILCD). In addition to metadata definitions, the guidelines include specifications for organizing datasets through naming and categorizing product systems, unit processes, flows, and background information. For example, the two submitted processes were classified under folder “ISIC 2520 Manufacture of gas” and “ISIC 1610 Sawmilling and planning of wood,” respectively.

Multiple Data Sets Integration into openLCA

Individual unit processes are linked together through the exchange of material, energy, and/or service flows into an integrated product system. The following steps introduce the connection of multiple related data sets into product system, for example, to connect the new “whole tree chips” unit process to the existing “wood chip pyrolysis” unit process followed by creating a syngas producing product system. In the LCA Commons, CUTOFFs are technosphere flows terminated without an upstream provider. In this case, we will replace this CUTOFF flow with a provider from a new unit process. The wood chip pyrolysis unit process is a recipient of the flow “CUTOFF whole-tree-chips...,” the whole tree chips unit process is a provider for “whole tree chips...,” and the task will be to merge these two within openLCA and build a product system.

To set up the openLCA database, (1) create a new database (with units and flow properties); (2) import wood chip pyrolysis unit process (in JSON-LD/ILCD format); and (3) import whole tree chips unit process (in JSON-LD/ILCD format). Then merge the whole tree chips flow as follows: (1) work with openLCA’s “bulk-replace” feature (Window > bulk-replace > Flows); (2) in “Replace flows”

select “CUTOFF whole-tree-chips, softwood, green, at sawmill, INW”; and (3) in “with” select “whole tree chips; softwood; at sawmill; INW” and select “Finish.” At this point, all instances of the CUTOFF flow have been replaced with the whole tree chips version of “whole tree chips...” everywhere it occurs in the database caveat emptor. Further, to build the product system, (1) open the “reference process,” in this case “wood chip pyrolysis”; (2) select “Create product system” in the “General information” tab of the unit process view; and (3) select “Add connected processes” and click finish. This will link the two process (and any other upstream processes with consistent flows as described above) into a new “product system.”

Finally, export the product system as JSON-LD for your records. JSON-LD is the only format currently supported by LCA Commons. The product system provides a convenient publishable unit of all individual unit processes, the explicit connections between them all, and all the necessary dependencies to recreate the data set in a new instance of openLCA.

Committing to the NAL LCA Collaboration Server

Submission to the LCA Commons is performed through the openLCA user interface. NAL staff will provide a URL to data providers with step-by-step instructions on how to commit data to an LCA Commons repository. Once a data set has been committed, staff at NAL reviews the data set for consistency with the documentation guidance and will contact the submitter directly if any changes are required. Upon acceptance for online publication, a DOI number will be available and the dataset is open to the public and downloadable (Gu and Bergman 2018).

Discussion

The steps presented for this proof-of-concept outline the basic procedure for preparing a SimaPro data set for publication in the LCA Commons. This procedure extends for full LCA data sets, with the exception of the management and treatment of environmental flows. Connecting new openLCA imports from SimaPro to openLCA’s standard impact methods requires additional hands-on work. Documentation and procedures for performing this curation is a current work in progress within the Federal LCA Commons. Additionally, as data sets increase in size, there is a proportional increase in the number of “bulk-replace” routines that will need to be performed to ensure that published data sets will connect to standard background data sets such as the USLCI and Ecoinvent.

Summary

The forestry LCI data were successfully transformed and compiled in openLCA framework and submitted online

to the publicly available database LCA Commons based on the guidelines and direct training services from NAL. The FPL team will use this experience to publish full LCA data sets and use the knowledge learned to develop a fully documented, step-by-step workflow for publishing data on the LCA Commons. This workflow will serve to aid our projects as well as other team members of the Federal LCA Commons for future project LCA data management needs.

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Literature Cited

- Anderson, N.; Bergman, R.; Chung, W.; Elder, T.; Elliot, W.; Englund, K.; Essen, M.; Han, H.; Hensen, R.; Hogland, J.; Jump, K.; Keyes, C.; Kimmerly, A.; McCollum, D.; Page-Dumroese, D.; Peters, L.; Sells, C.; Spivey, J.; Tucker, R.; Twer, M.; Venn, T.; Ververis, A.; Windell, K.; Young, J. 2016. Integrating sustainable biofuels and byproducts into forest industry supply chains. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.
- Arbuckle, P.; Kahn, E.; Kriesberg, A. 2017. Challenge paper: Challenges to sharing data and models for life cycle assessment. *Journal of Data and Information Quality*, 9(1). DOI: <https://doi.org/10.1145/3106236>
- Ecoinvent. 2018. Available at: <http://www.ecoinvent.org/database/older-versions/ecoinvent-version-2/methodology-of-ecoinvent-2/ecospold1/ecospold1.html>. (Accessed May 16, 2018.)
- Goedkoop, M.; Oele, M.; Leijting, J.; Ponsioen, T.; Meijer, E. 2016. Introduction to LCA with SimaPro, PRé. <https://www.pre-sustainability.com/download/SimaPro8IntroductionToLCA.pdf>. (Accessed [May 16, 2018].)
- Gu, H.; Bergman, R. 2016. Life-cycle assessment of a distributed-scale thermochemical bioenergy conversion system. *Wood and Fiber Science*, 48(2): 129-141.
- Gu, H.; Bergman, R. 2018. Unit process data for distributed renewable syngas production. USDA National Agricultural Library. <https://data.nal.usda.gov/dataset/unit-process-data-distributed-renewable-syngas-production>. (Accessed May 16, 2018.)
- ISO. 2002. ISO/TS 14048. Environmental management – Life cycle assessment – Data documentation format. Geneva, Switzerland: International Organization for Standardization.
- NAL. 2017. LCA Commons Submission Guidelines. USDA National Agricultural Library, pp 1-53. https://www.lcacommons.gov/sites/drupal.lcacommons.gov/files/lcaCommonsSubmissionGuidelines_Final_2017-03-13.pdf. (Accessed May 16, 2018.)
- Noi, C.D.; Ciroth, A.; Srocka, M. 2017. openLCA 1.7 Comprehensive User Manual, GreenDelta. http://www.openlca.org/wp-content/uploads/2017/11/openLCA1.7_User_Manual_v1.1.pdf. (Accessed May 16, 2018.)